

# Foam Protection of Flight Hardware From Impact Loads Due To Drops

Completed Technology Project (2012 - 2012)



## Project Introduction

In response to several instances of flight hardware being dropped during shipment with expensive hits to cost and schedule, a methodology to normalize foam data was proposed, developed into an algorithm and implemented as an excel based foam design tool. Commonly foam curves are developed from thousands of drop tests. This algorithm allows the same results to be obtained from about 100 tests, reducing cost of testing foams. This preliminary tool has passed peer review at JSC Engineering and received acclaim. JSC Innovation Charge Account funding was used to refine the tool to obtain higher accuracy by improving the math and conducting additional testing to expand the math to include foam sandwiches. These improvements to the tool help reduce the amount of foam required allowing the package to be more compact, and reduce the need to ship in ground foam then repackage in flight foam at the launch site. This will result in cost saving, schedule compression and reduced risk to hardware.

Develop an algorithm to model foam compression during impact and implement as an easy to use excel based shipping foam design tool. Refine methodology of calculating foam compression using the innovative Stress-Energy testing method which drastically increases flexibility of data collected by normalizing data with respect to drop height and foam volume. Foam compression is critical in cases where a protrusion exists which should not contact the bottom of the container. There are benefits of using multiple foam types or sandwiched foam packaging. Tests were conducted to confirm the theory for how to combine foams as well as add the function to the existing tool. Calculations for sandwiched foams along with the addition of flight foams to the data base provides tools required for engineers to properly design foam packaging when multiple foams would be beneficial. This provides the option to pack hardware for flight then ship hardware to launch facility.

## Anticipated Benefits

This tool was used to design shipping foam to protect ISS and Orion hardware for various Engineering Directorate divisions (EA3, ER, EC, EV) at JSC.

The final version of the tool is being used to package hardware and protect it from the water landing impact of the Dragon spacecraft returning from the ISS.



Foam Protection of Flight  
Hardware From Impact Loads  
Due To Drops

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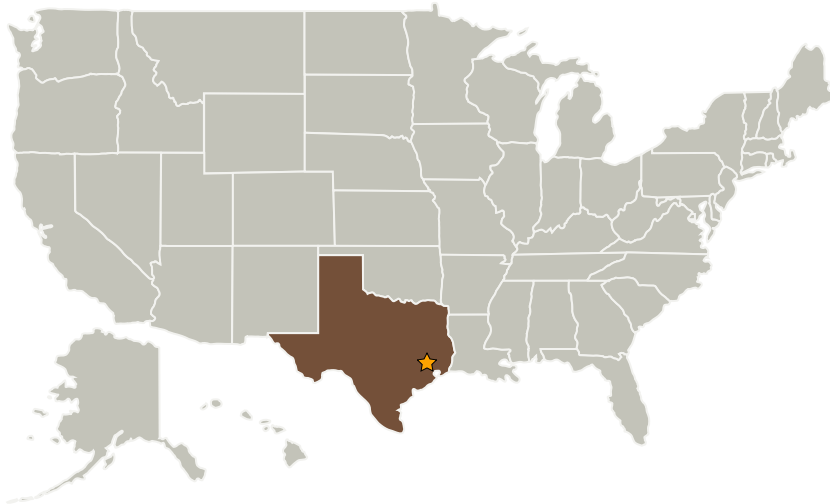
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## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas
Jacobs Engineering Group, Inc.	Supporting Organization	Industry	Dallas, Texas

### Primary U.S. Work Locations

Texas

## Links

NTR 1

(<http://Case Number: MSC-25515-1, Technology Title: Shipping Foam Designer Software>)

## Organizational Responsibility

### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

### Lead Center / Facility:

Johnson Space Center (JSC)

### Responsible Program:

Center Innovation Fund: JSC CIF

## Project Management

### Program Director:

Michael R Lapointe

### Program Manager:

Carlos H Westhelle

### Project Manager:

Satish C Reddy

### Principal Investigator:

Satish C Reddy

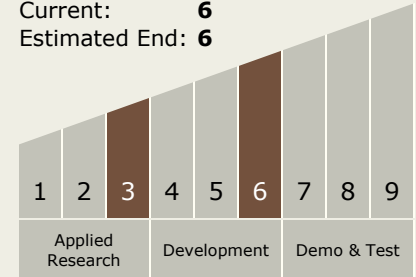
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## Technology Maturity (TRL)

Start: **3**  
Current: **6**  
Estimated End: **6**



## Technology Areas

### Primary:

- TX14 Thermal Management Systems
  - └ TX14.1 Cryogenic Systems
    - └ TX14.1.4 Ground Testing & Operations